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A DEVICE FOR SEPARATING DIFFERENT LENGTHS OF FIBERS FROM SEED COTTON

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INTRODUCTION

Cotton breeders and investigators are familiar with the variation in the length of lint between individual plants or from different bolls from the same plant. Data have been collected by many investigators concerning the yield, length, and percentage of lint of different varieties of cotton, but relatively little information is available regarding the degree of uniformity of lint produced by one variety as compared with another. Cook (*4*, *5*)[2] has recently called attention to differences among the fibers on the same seeds, and also the value of making combings of locks from consecutive plants as a means of determining the uniformity of a seed stock. Although a continuous series of graduations in fiber lengths is recognized, the fibers that are much shorter than the commercial staple length are considered as "substaple", while the few long fibers that notably exceed the commercial staple length are referred to as "superstaple." Though the substaple and the superstaple are disregarded in commercial classing, their existence must be recognized in making detailed comparisons between the fiber characters of different varieties.

Balls (*2*) states: "Those who have thus become familiar with the real length composition of a cotton sample can only wonder that any arbitrary statement of 'staple length' was ever taken seriously." The proportions of different fiber lengths are matters of special interest to the cotton breeder and present a field for improvement which generally is overlooked. Though no data have yet been published showing genetic differences in the proportions of substaple and super-

[1] The writers are indebted to Frank Riegger for valuable suggestions and mechanical assistance. Models used in these experiments were made in the shop of Riegger & Wright, of Greenville, Tex., whose cooperation and assistance were freely given at all times. Public service patent no. 1957411 was granted the authors on May 1, 1934.

[2] Italic numbers in parentheses refer to Literature Cited, p. 12.

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staple in varieties of cotton, such differences undoubtedly occur and the problem should engage the thought and attention of all cotton breeders.

The range of variation in length of individual fibers on the seed is often an inch in short cottons and is correspondingly greater in Egyptian and sea-island cotton. When the fibers are paralleled on the seed with a comb and the longer ones pulled out, the shorter substaple fibers may be seen easily.

Fundamental improvements in the quality of cotton must come about through the labors of the cotton breeders, and it is of the utmost importance that some simple method of fiber analysis be available to them. It is already known that there is considerable variation in the amount of substaple produced on different seeds, and analyses are being made of different strains and varieties. If a low percentage of substaple and superstaple can be demonstrated as a character that responds to selection, a vast improvement in the uniformity of lint is possible. Not only may improvements in uniformity of fiber be made, but other lint characters may be studied more closely and evaluated.

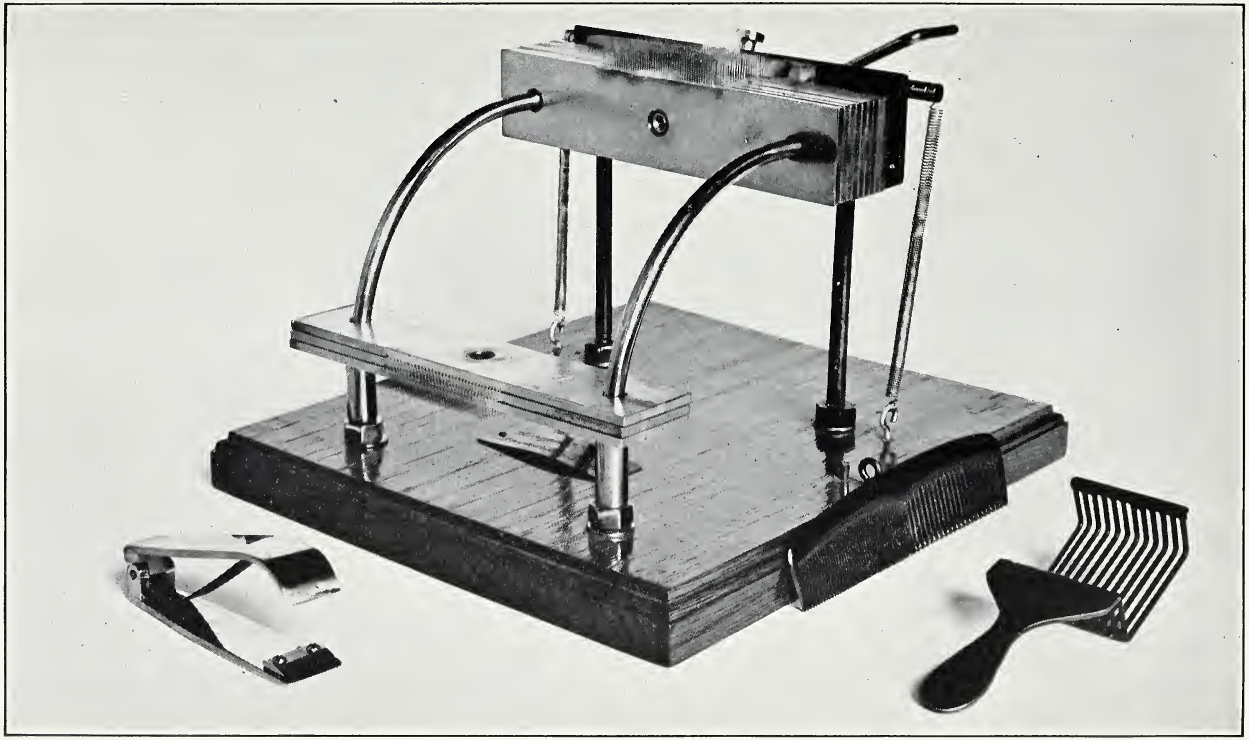
One reason for the failure of breeders to take up this phase of cotton-improvement work has been the fact that no practicable means of measuring the variation in fiber lengths was available. The Baer sorter has fulfilled a need in analyzing commercial samples and the Suter-Webb (*7*) sorter, which is an improvement on the Baer sorter, serves a similar purpose. These sorters, however, have been designed primarily for use with samples of lint cotton, and have been employed to a considerable extent by cotton technologists but only to a limited extent by cotton breeders, because the methods take much time and require an operator of considerable skill.

Pressley (*6*) recently announced a new type of cotton sorter which he developed for determining the amount of substaple in seed cotton. The writers have also developed a sorter for seed cotton to a point where the general mechanical details have been worked out. Information on this is presented, since it has certain advantages which may prove useful to others and which may be further refined by them through use and experience.

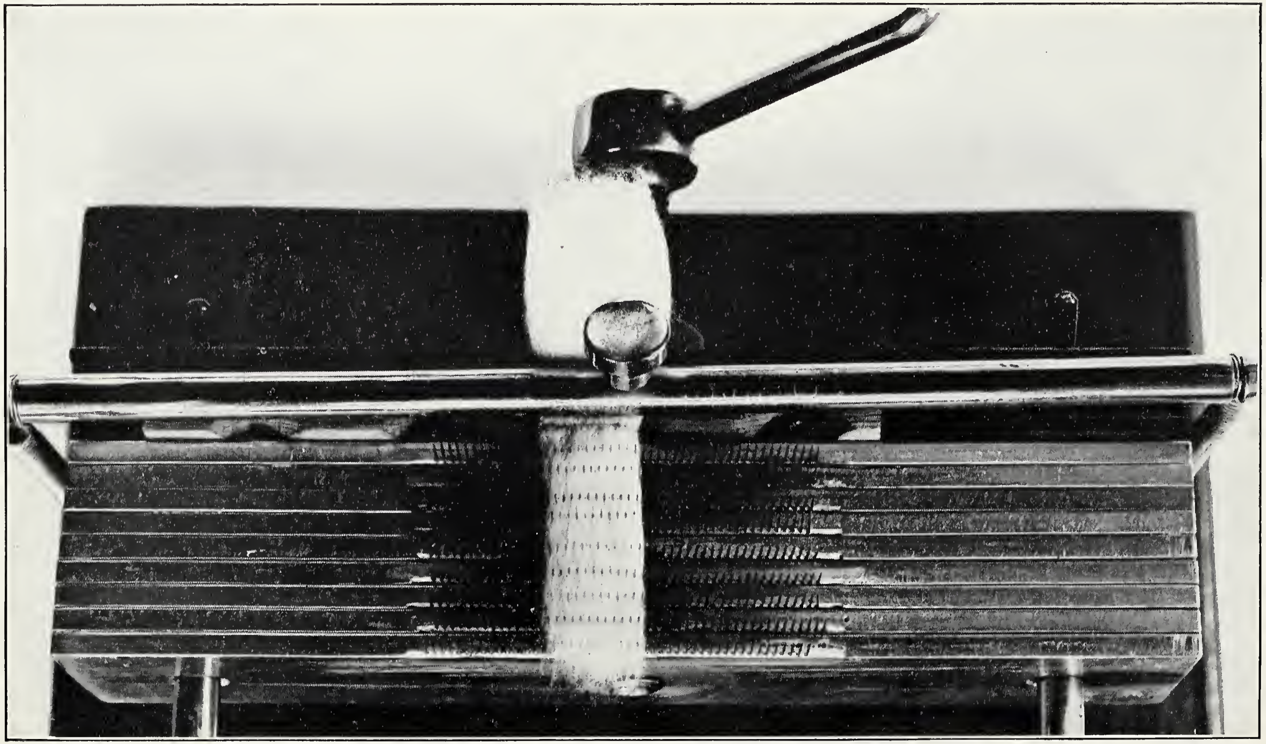
DESCRIPTION OF SORTER

The sorter here described has been developed to array the fibers from one seed at a time. It consists of a series of parallel brass combs one-sixteenth or one-eighth inch in thickness, which fit closely together and may be engaged or released separately by the turning of a screw at the back (pls. 1 and 2). The combs are mounted on two round guide rods extending forward and bending downward to the base. As each successive comb is released it slides forward on the guide rods and comes to rest in a horizontal position below, leaving a small tuft of fibers protruding from the remaining combs which can be pulled out easily. When an array has been completed, the entire series of combs may be returned to position by sliding them back by hand and locking with the screw. The seeds with combed fibers attached are held in place by an adjustable strip provided with forward sloping concavities in which the seed is snugly fitted.[3] A bar with adjustable

[3] The writers are indebted to O. F. Cook, principal botanist, Division of Plant Exploration and Introduction, for suggesting a concavity for holding the seed in position while the fibers are being pulled from it.



Seed-cotton-fiber sorter, showing mechanical features of construction with three combs in resting position, together with comb, forceps, and pusher.



Close-up view of seed-cotton-fiber sorter.

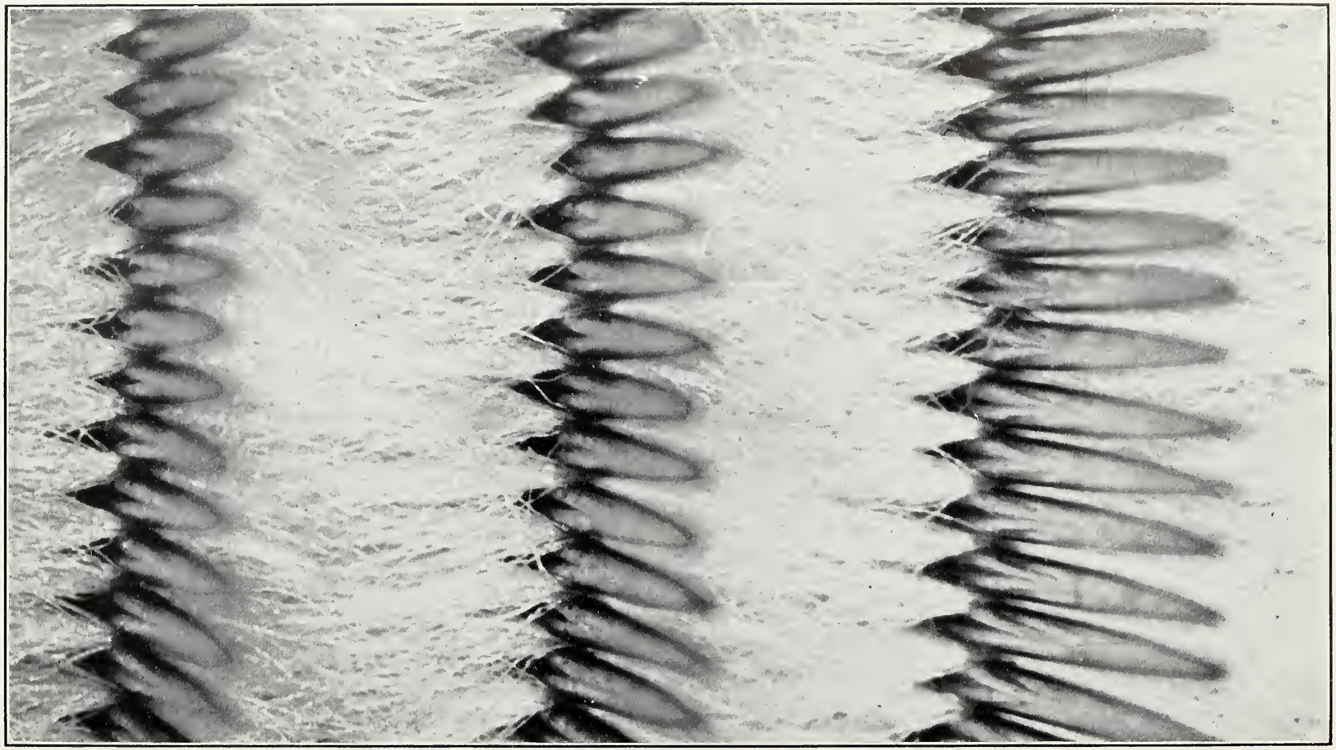
spring tension is placed over the seed and forces it forward and downward, thus preventing movement during the pulling and arraying process.

After experimenting with several different sizes of teeth and spacings of the combs it was determined that comb strips one-sixteenth or one-eighth inch in thickness with teeth about one sixty-fourth inch in diameter spaced 24 to the inch is a workable combination. When the teeth are too closely spaced there is a tendency for the fibers to "wedge" between them, causing excessive friction and resulting in a certain amount of breakage and slippage of fibers (pl. 3). With larger teeth spaced 16 to 25 to the inch there is considerable zigzagging of the fibers as they are drawn through the combs. This causes the fibers to bind around the teeth, giving a rough sensation to the pull and some breakage. With smaller teeth, spaced about 24 to the inch, better parallelization of the fibers is possible (pl. 4), and they pass through the combs with less friction.

The object of having combs one-sixteenth or one-eighth inch apart is to indicate the length of the fibers in each pull, though this has not been entirely possible owing to the resilience of the fibers. The first fibers pulled from the seed measure somewhat longer than is indicated by the calibrations on the sorter. This curling of the fibers was noted by Allard (*1*) in 1907, and also by Cobb (*3*) in 1915. As the shorter lengths are reached, the spread naturally becomes less. This behavior of the fibers makes the calibration of the sorter difficult for lengths below five-eighths inch, but for lengths of five-eighths inch to 1¼ inches it is possible to use the combs as a rough index to length, thus simplifying the operation to some extent. For some purposes the breeder may be interested only in the percentage of fibers in the groups ranging from five-eighths inch to 1¼ inches or possibly from seven-eighths inch to 1⅛ inches, placing the remainder of the fibers in a single group. In such cases, the operation may be speeded up and practical results readily obtained.

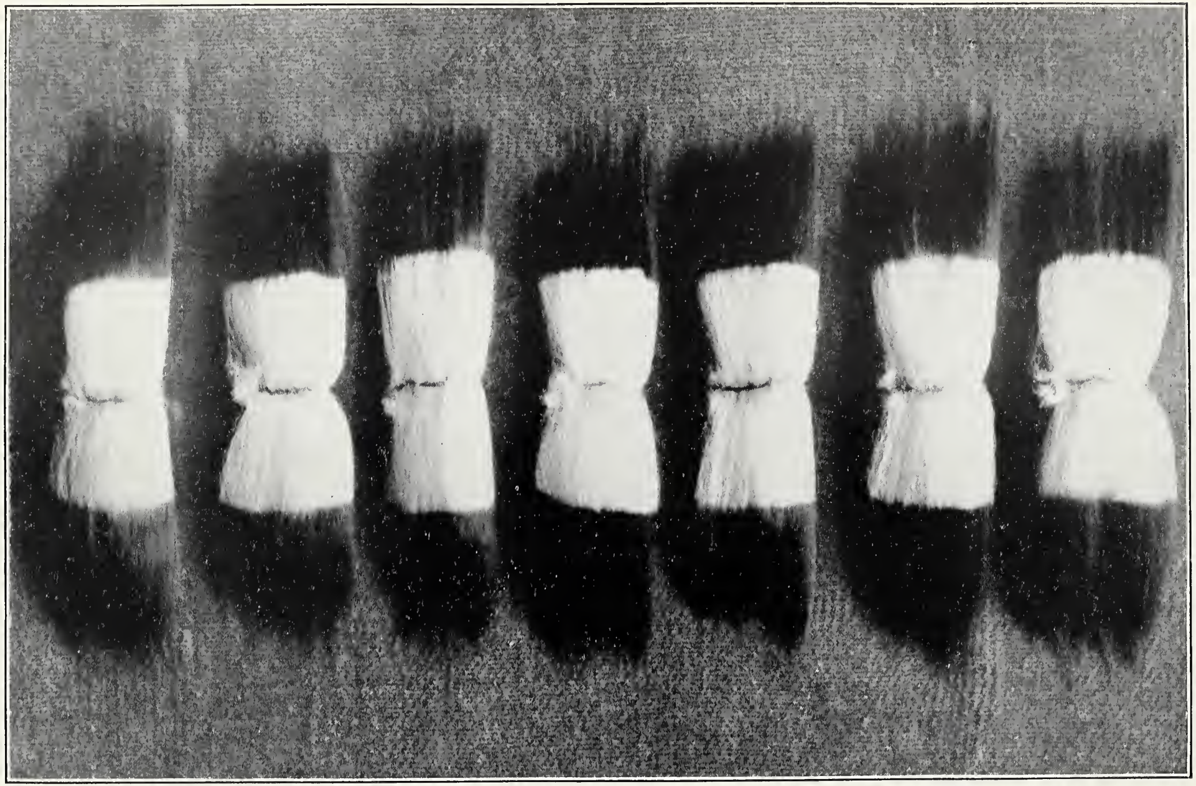
BREAKAGE AND SLIPPAGE OF FIBERS

A simple method was devised for comparing the effect of spacing of comb teeth on the breakage of fibers. The outer ends of the combed fibers on both sides of several seeds were dyed red, as shown in plate 5. The fibers from one side of the seed were then arrayed through the seed-cotton sorter, those on the other side being pulled from the seed in a body and arrayed on a lint-cotton sorter. The arrays of fibers from the seed-cotton sorter showed a distinct line where the red dye began, while the arrays made on a lint-cotton sorter showed no distinct line, but did reveal some red and white fibers scattered throughout the array, with a considerable number of red fibers intermixed throughout the shorter lengths. The only apparent explanation for the short red fibers found in the shorter groups of the arrays was breakage, while the appearance of red fibers among the longer solid white fibers was due to slippage in the combs, since they did not appear in corresponding groups when arrayed on the seed-cotton sorter. Whether or not the error introduced by breakage and slippage in the lint-cotton sorter is greater or less than the experimental error of the seed-cotton sorter has not been determined.



Fibers in place in a lint-cotton sorter which has very fine teeth closely spaced. With this sorter there is a tendency for the fibers to wedge between the teeth, producing much friction. × 15.

Fibers in seed-cotton sorter with 24 small teeth to the inch. Good parallelization of fibers is obtained, and there is no tendency for the fibers to wedge between the teeth and contribute to breakage. × 15.



Cottonseeds with fibers combed and dyed preparatory to making comparison of arrays from the seed cotton-fiber sorter with few comb pins and a lint-cotton sorter with many fine comb pins. The fibers from one half of each seed were arrayed with the seed-cotton sorter and those from the other half with a lint-cotton sorter, and the distribution of the colored fibers and their position in the array carefully noted. Natural size.

PREPARATION OF SEED COTTON FOR FIBER ARRAYING

The first operation in preparing seed cotton for staple analysis is the careful combing of the fibers after they have been "parted" along the raphe on the inner side of the seed. This method has been described and illustrated by Cook (*4*) and is known to most cotton breeders. To determine the distribution of the fiber lengths the combing of the fiber on the seeds should be done very carefully in order to reduce breakage and waste of fibers to a minimum. When combed, the seed cotton is placed in the sorter at a right angle to the combs. The fibers are seated into the combs with a wire depressor or pusher and the bar with the spring tension is placed over the seed. The combs are released successively until the ends of the longer fibers project beyond the teeth of the combs. These ends are then firmly gripped with a pair of forceps, pulled out, and laid on a board covered with black velvet. When all of the fibers projecting beyond the outside comb are drawn, this comb is released and the fibers of the next group are pulled out, and so on, until the lengths desired have been pulled, or the array has been completed.

LOSS OF FIBERS IN COMBING

While the "waste" from the preliminary combing probably will vary with the variety and also the operator, it can be held fairly constant with reasonable care. The mean weight of the fiber array and combing waste from one side of a seed is shown in milligrams in table 1 for 20 determinations each on six different varieties. The percentage of fibers arrayed and the percentage of combing waste are also given.

TABLE 1.—*Mean weight and percentage of fibers, in array and in combing waste, based on 20 determinations from each of six varieties of cotton* [1]

Variety	Weight			Fibers on seed after combing	Combing waste
	Fibers on seed after combing (array)	Combing waste	Total		
	Milligrams	*Milligrams*	*Milligrams*	*Percent*	*Percent*
Lone Star	37.54	5.69	43.23	86.84	13.16
Acala	26.69	4.24	30.93	86.29	13.71
Rowden	30.50	6.88	37.38	81.59	18.41
Delfos	19.10	5.48	24.58	77.71	22.29
Kekchi	26.48	6.28	32.76	80.83	19.17
Half and Half	27.68	4.08	31.76	87.15	12.85

[1] Fiber arrays and calculations by D. D. Porter and T. R. Richmond.

In this test the mean waste for all varieties was 5.44 mg, or 16.59 percent, and excepting the Acala with 13.71 percent, which was almost as low as Half and Half with 12.85 percent of waste, there was a definite tendency toward an increase in waste in the varieties with longer staple. Occasionally the waste from a single seed ran as high as 10 to 11.5 mg. Where an excessive amount of waste occurs from too severe combing of entangled fibers, the seed should be discarded for one with less waste.

The distribution of lengths in the waste fibers from combing, as determined with a sorter designed for lint-cotton samples, shows that the combing waste contains the full range of lengths that occur on the seed. The waste, therefore, apparently contains proportionate amounts of all lengths of fibers borne on the seed. These fibers measured somewhat longer than when pulled directly from the seed by hand, or from the seed-cotton sorter, as more parallelization of the fibers is obtained by pulling them through the very fine combs of the lint-cotton sorter. Fiber-distribution curves for an array from a composite sample of waste from the same variety made on a lint-cotton sorter are shown in figure 1, together with the curve of a mean

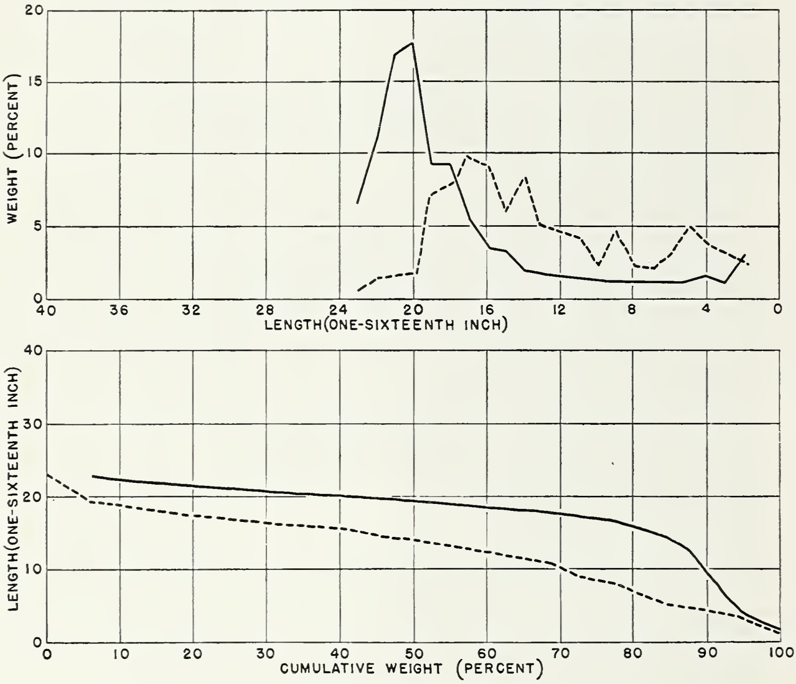
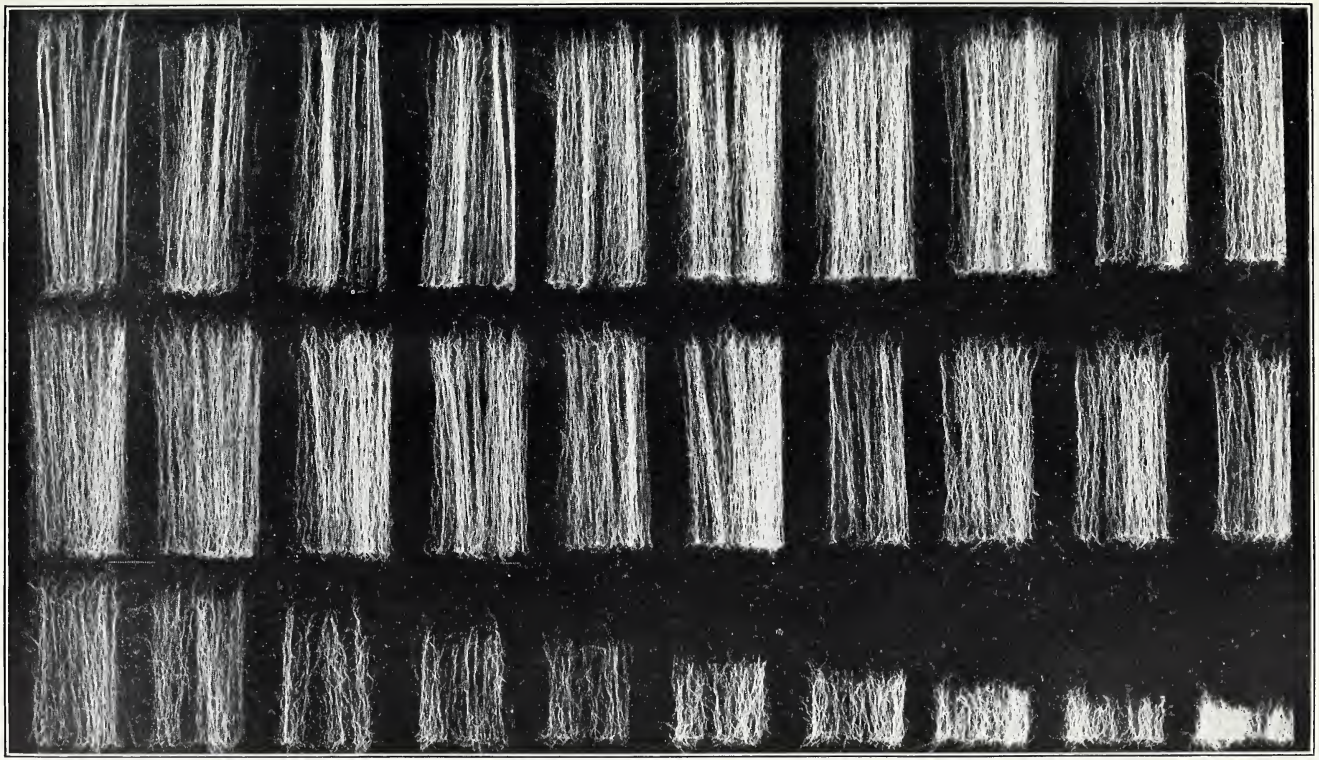


FIGURE 1.—Relation in length between the fibers pulled directly from the cottonseed on the seed-cotton fiber sorter, as indicated by the solid line, and an array of the fibers detached from the seed in the combing operation necessary in preparing the seed cotton for a fiber array, by a dotted line. The full range of lengths were represented in the waste sample, although it contained a preponderance of shorter fibers.

for 20 arrays from Acala cotton made with the seed-cotton sorter and similar to that shown in plate 6. A comparison of these two curves shows that breakage of fibers undoubtedly occurs in combing out the tangles, since the different groups from the combing waste are consistently shorter than the fibers pulled directly from the seed.

EFFECTS OF CURVATURE OF SEED ON FIBER MEASUREMENTS

Study has been given to the question of error in measuring the groups of fibers pulled from the seed. The base of the group is uneven, owing to the curvature of the seed, and some fibers appear longer than others, although as a rule the spread in length is less than one-sixteenth of an inch. There is likewise considerable varia-



Fiber array made with seed-cotton-fiber sorter from one side of a seed of Acala cotton, showing length distribution of fibers in a well-bred variety. The ends of the fibers in the second group from the left of the middle row are shown in plates 7 and 8. About natural size.

tion in length of the loose ends projecting from between the comb teeth. Gripping these ends with the forceps and placing the pulled groups of fibers on velvet has a tendency to mask the irregularity and make them appear more even in length. Also, when the ends of the fibers are gripped with the forceps a slight indentation is made in the fibers, causing the ends to curl, as shown in plate 7. In plate 8, the ends that were attached to the seed are shown, and it will be noted that there is not as much variation as might be expected. When the groups of fibers are pulled from the seed they apparently come off from all parts of one side, and the shortest, together with the longest ends, make up but a small portion of the group of any single pull. The writers consider this variation within the range of toleration for this class of work and as not representing a source of serious error.

A simple device has been developed to facilitate measuring the individual fiber groups of an array. By means of this it is possible for operators to obtain a faster and more accurate determination of length than with an ordinary rule. This device (fig. 2) consists of a

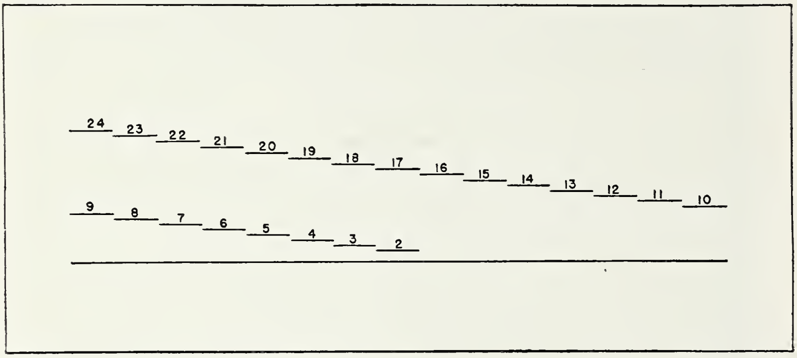


FIGURE 2.—A design similar to that shown above etched on a piece of transparent celluloid facilitates accurate measures of each group of fibers. The celluloid may be moved at will over an array of fibers without disturbing them and the lengths recorded in sixteenths of an inch.

transparent piece of celluloid upon which are etched a series of horizontal lines one-sixteenth of an inch apart from a common base line. The celluloid may be placed over the array, moved about without disturbing the different groups of fibers, and the length of each group may be more accurately determined.

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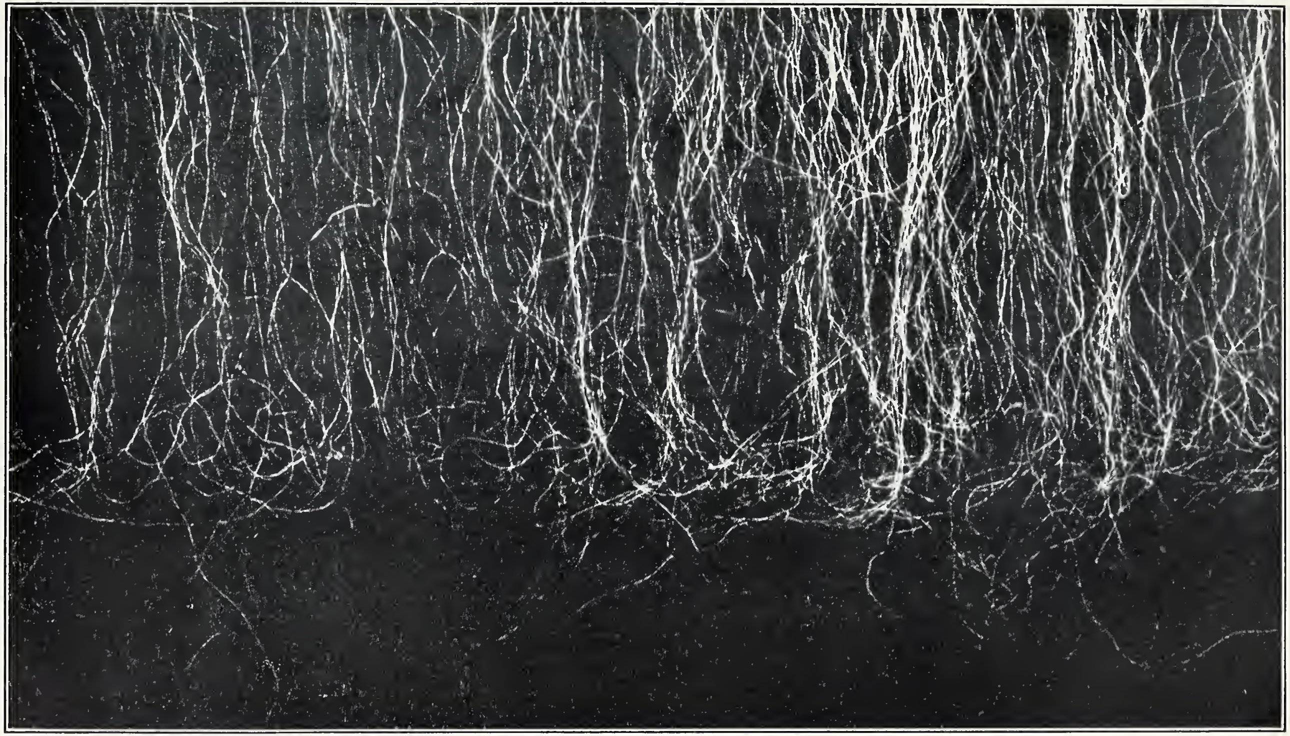
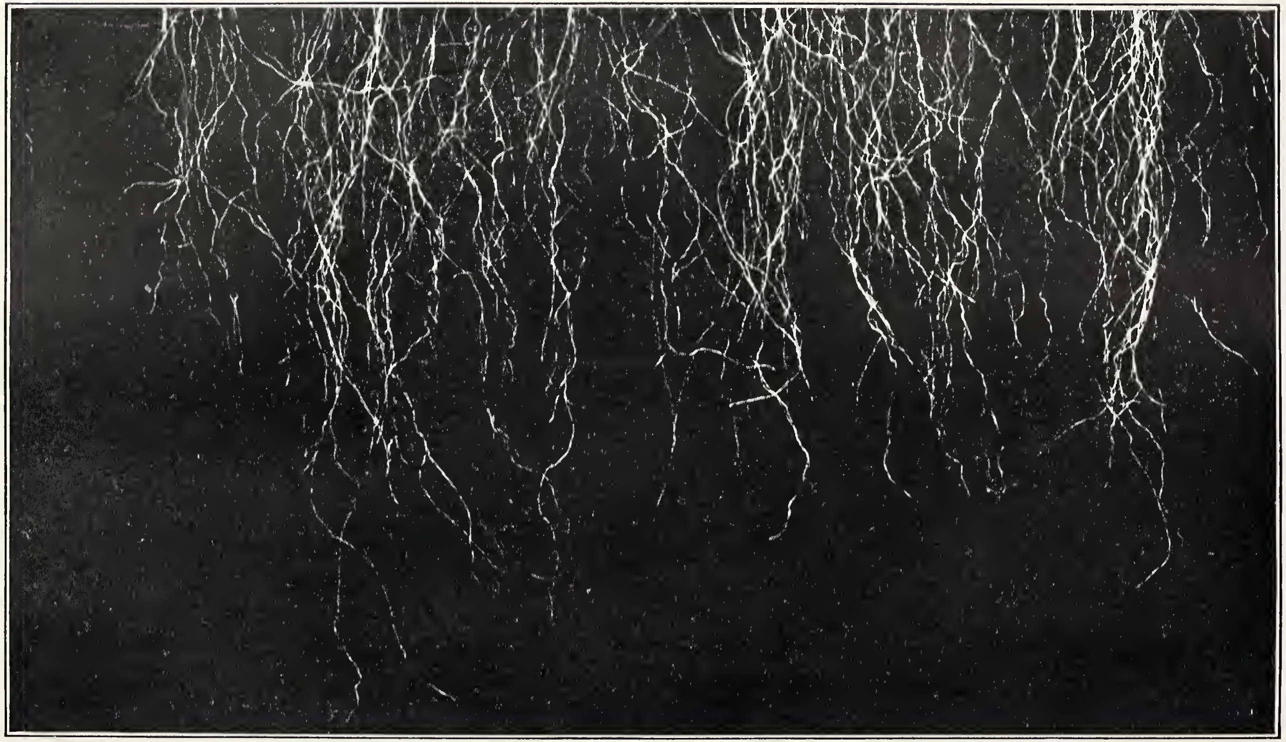


Distal ends of a group of fibers pulled from seed, showing uneven ends due to curling of fibers where gripped with forceps. × 13.



Basal ends of the group of fibers shown in plate 7, which also appear very uneven but probably are as regular as the outer ends. This is an enlargement of the group of fibers shown as the second from the left in the middle row of plate 6. × 13.

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